The "Unknown Bourne" of Atlantic Ocean Weather

Problems of the Air, as Aeroplane Voyagers Will Find Them, Explained by a Meteorologist

By Prof. Frank Waldo, Ph. D.

THE ruling weather conditions form a most important factor in the transatlantic flight, and upon the selection of the proper air conditions, more than upon any other feature except the proper functioning of the engines, will depend the success of the attempt.

No one who is not well versed in the science of meteorology realizes the difficulty in selecting the right weather conditions and appreciates sufficiently the cautious delay of the British aviators in making their start.

The facts concerning the air conditions are, briefly stated, as follows:

North of about latitude 40 there is a constant procession of huge atmospheric whirls progressing in an easterly direction at greatly varying speeds across the ocean. These huge whirls are the cyclones (areas of low barometer) and out cyclones (areas of high barometer) usually from 500 to 1,000 miles across and a mile or two deep, but each with a circulation of air distinctly its own.

In the cyclone the wind blows from the outer rim inward spirally toward and around the centre (counter clockwise) at the ground, or sea level, and at low altitudes. But these directions veer toward the right with ascent and up in the air, a mile or two, the winds blow outward and away from the centre counter clockwise. So that near the *surface of the ground* or *sea* the winds on the front of the cyclone blow toward the centre from the south, southeast, east and northeast, oriented from south to north; while the winds at the rear of the cyclone blow from the north, northwest, west and southwest, oriented from north to south. But *aloft* the winds blow from the centre from the northwest, west and southwest, oriented from south to north, on the front of the cyclone; and from the east, northeast, north and northwest, oriented from north to south, at the rear of the cyclone.

The surface winds increase in velocity as the centre of the cyclone is approached; and the upper winds in general decrease somewhat as they recede from the centre.

The southeast quadrant (90 degrees) of the cyclone is the region of clouds, rain, thunder squalls, violent local winds; and in fact is the dangerous area where "bumps" are likely to occur to disconcert the aviator.

The air on the eastern side of a cyclone is usually warm and cold on the western side.

In the anticyclone the wind blows from the centre outward spirally around the centre toward the outer edge (clockwise), at the ground or sea level; and at low altitudes; but these directions change with the ascent and at high altitudes of a couple of miles the wind blows still inward and around the centre in a spiral clockwise.

The *surface and lower winds* at the front of the anticyclone blow from the centre and from the north, northwest and west, oriented from south to north; while the winds at the rear of the anticyclone blow from the south, southeast, east and northeast, oriented from the north to the south. But *aloft* the winds at the front blow spirally toward the centre from the south, southeast, east and northeast, oriented from south to north; while at the rear they blow from the north, northwest, west and southwest, oriented from north to south.

The air is usually clear or with but little cloud in an anticyclone. The front or eastern side is cold and the western side warmer.

In effect a cyclonal air movement (counter clockwise) near the ground is changed to an anticyclonal movement (clockwise) high above the ground. So also an anticyclonal air movement (clockwise) at the ground is changed to a cyclonal (anticyclonal) movement high aloft.

One Cyclone After Another

There are usually three or four cyclones and anticyclones passing across the American continent from west to east at any one time, with their centre a thousand miles or so apart, the more eastwardly at a speed of about thirty miles an hour, and their passage gives us our changes in wind and weather.

Over the North Atlantic Ocean there are seldom more than two or three of these cyclones and anticyclones and they generally pursue a more northeasterly course, going from the latitude of Boston (say) to that of London; and the move eastwardly only about twenty miles an hour, which is much slower than in America.

These cyclones and anticyclones change their shape somewhat in crossing the ocean and become more symmetrical with stronger and steadier general winds, and comparatively slow changes in the wind direction. As the cyclones approach and reach the British and French coasts they change again somewhat in form and character and the wind changes become very abrupt.

A west wind is desirable for the best flight conditions; for thereby the speed of the aeroplane would be increased by the speed of the wind. For a head wind the true movement of the 'plane would be the speed of the 'plane diminished by the speed of the wind.

Cross Winds The Real Danger

But cross winds are the most troublesome. In flying straight through a cyclone from west to east it can be seen that for low altitudes a cross wind from the north would be encountered on the west side, at the centre strong veering winds, and on the east side cross winds from the south. In flying at high altitudes a head or partly cross wind from the north would be met on the west, and west or concurrent winds on the eastern side.

There have been at various times daily surface weather charts published of the Atlantic Ocean and the neighboring mainlands of America and Europe: The international charts published by the signal service in the seventies; the long series of Hoffmeyer-Neumayers daily synoptic weather charts of the '80s and '90s published by the Danish and German governments, and the daily charts of the northern hemisphere published by the United States Weather Bureau from January 1, 1914, and which were interrupted by the war. The knowledge derived from those charts of ocean level atmospheric conditions, particularly of the winds, supplemented by studies of the upper air made at the two continental ends of the line of flight, forms the basis of the ocean flight weather prognostications.

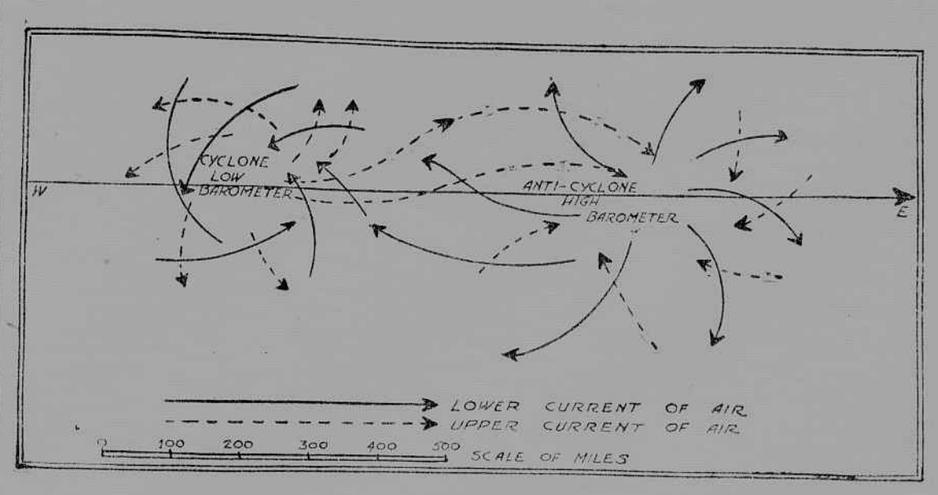
Over the North Atlantic Ocean there is in general a high barometric pressure south of latitude 45 degrees with correspondingly stable weather, and a low pressure to the north. In the neighborhood of Iceland there is a very low average pressure, and that region is correspondingly stormy.

Newfoundland's Frequent Fogs

The fog conditions just east of Newfoundland are very bad. Directly off the coast at this season of the year about 45 per cent of the days are foggy, so that for the first 250 miles from St. John's the fliers most likely will have fogs to obscure the surface waters; but 500 miles east of St. John's the fog conditions have become so much bettered that only one day in five is foggy.

The prevailing surface winds over this part of the course are from the west, and for the higher flying heights from the northwest; but it will be the conditions on the day of flight that will control the destiny of the aviators, and not average conditions.

The best preparation for the transatlantic flight necessitates the transmission of information of the current daily weather conditions in the eastern United States and Canada, and the air conditions over the North Atlantic and northwest coast of Europe by wireless from ships to the point of departure in Newfoundland, so that the types of weather to be encountered can be prognosticated. These conditions in connection with the local weather conditions furnish the entire working weather plan.



Experience Gained In War

When the American aviators were flying at the front they had posted for their information the wind conditions at various flying heights for the day of journey. These were carefully worked out by the meteorologists based on the weather map conditions and the particular place of flight; for the environment had to be most carefully taken into account. For the ocean aviator the environment is the broad Atlantic. For the ocean flights, for the first part of the trip, the conditions aloft as related to those at sea level for the region of the Blue Hill Observatory would be generally applicable. For the last part of the flight, straight across, the conditions found to obtain for the British Islands, where numerous observations have been made, would be applicable. But for the greater part of the ocean trip the aviator would have to depend on pure theory and the meagre records of cloud observations that are available as indicating the upper winds on the North Atlantic. We know that the lower air conditions are not quite the same in midocean as on land, and just in so far as our observed information regarding upper air currents at sea falls short, there will be an uncertainty for that 1,500 miles of air navigation in midocean.

The accounts that come to us of the close watch that the aviators in Newfoundland are keeping of the local weather conditions make one feel that those local air conditions are playing a too important part in the plan. To be sure, it is highly important that the local starting conditions should be as favorable as possible, because the start is like the "take off" in a running jump, and well started is well begun; but the jump has still to be made.

By choosing the proper condition a westerly wind may be secured for the whole journey by taking a high altitude for the flight.

Following the Handy Ship Lane

The northern route, straight from Newfoundland to Ireland or the English Channel, will offer the protection of the transatlantic steamships, for by swerving slightly to the south all but the first five hundred miles of the aviators' course can be directly over the ship lanes and their security much increased by opportunities for radio or rocket communication.

For a flight from Newfoundland to Ireland at high altitudes an area of low barometer just west of Newfoundland and an area of high barometer over the eastern North Atlantic would be most favorable, since this would give southwest or west or northwest winds across the ocean in the upper air. But a strong objection to this would be that the start would have to be made in stormy local weather.

There are three weather phases of the transatlantic flight problem, and it is absolutely necessary to consider them separately.

1. The weather at the start, and Newfoundland weather is about as "mean" as is to be found anywhere. It covers the first few hundred miles of the flight and extends over the foggiest and most uncertain navigation conditions to be met with anywhere. This covers the first few hours of the flight. Local atmospheric disturbances are prevalent in this region.

2. The weather conditions of the broad North Atlantic and stretching over a distance of 1,500 miles or more and covering the main period of the flight. The conditions here are more steady than at the ends.

3. The weather conditions for the landing and covering the coast of northwest Europe and extending out to sea one or two hundred miles, thus embracing the last two or three hours of the flight. The landing conditions can hardly be picked; they must be taken as found, and the gales of this section are historic.

The weather conditions to be selected for the flight must be the best averaging up that can be made of all three of these conditions.

The Question Of Altitude

The type of weather elected for the start-off will depend on whether the plans are made for a flight at high or low altitudes. If a low flight is planned, then the weather map of the North Atlantic, with observations made at sea level, will be directly useful. But if it is decided to make the main flight at high altitudes, then such a weather map will form the basis only of complicated calculations which will permit the drawing of a weather map showing the conditions at heights of one or two or three miles above the sea level. And herein lies the triumph of modern meteorology.

If the flight is to be made at low altitudes the most favorable weather conditions for the whole flight will be when an area of high barometric pressure lies over the middle and eastern North Atlantic, between the latitudes of 40 degrees and 50 degrees north, with a not too deep area of low barometric pressure lying far to the north, eastward of Iceland. The American law following the high should be over the eastern states, but not so close as to give an easterly wind for a start off.

This would give winds at low altitudes from the southwest or west nearly the whole way across the ocean.

On the Azores Route

In the flight by way of the Azores the aeroplanes would cross the track frequented by the transatlantic lines, but most of the way would be off the beaten track, and there would be little possible assistance from passing vessels. Of course, the distance of flight is much less, but this hardly outweighs the safeguard of vessels on the longer route.

By this route a new element of weather conditions enters, for in the passage from Newfoundland to the Azores the air conditions change very materially in type, the prevailing winds at sea level changing from west to north, whereas from Newfoundland to Ireland they remain the same to which the aviators of northern latitudes have been accustomed, although the prevailing winds change from west to a more uniform distribution from all points of the compass. Much of our knowledge of the upper air movements in the region of the Azores is due to the researches of Rotch and Clayton, of the Blue Hill Observatory, near Boston, the latter having made a voyage of upper air exploration into those latitudes and sent balloons aloft to ascertain the upper air current.

Dangers of the Azores

That local wind disturbances of a most serious nature are to be expected in the course of such a flight is most certain. They occur at all altitudes and from a variety of causes. But the most prolific source at high altitudes will be the huge billows that occur in flowing streams of air, just as water waves are raised by wind on a water surface, only about eleven hundred times the size of water waves in magnitude. The running into the troughs of these waves or into the spraying crests will cause a gustiness that will test the strength of the machines and the skill of the navigators. Winds of 100 miles an hour must be expected, and perhaps exceeded, making not only the preservation of the equilibrium of the machine difficult, but the position calculations very uncertain.

The instrumental difficulties of the flight will be exceedingly troublesome. The barometer is the key to the aviator's position in the air and, indeed, to the atmospheric conditions in general, and he can get no barometer readings at sea level during his flight. Consequently the uncertainties of the altitude will amount to as much as the irregularities in the barometric pressures from day to day, and may amount in extreme cases to a thousand feet, or even more. This might have considerable effect on the calculated speeds.

The instrumental determination of drift due to side winds may be subject to great error, since there will be no fixed ground object to use as a check. Thus, even such a looming objective as Ireland might be missed, and as for the Azores, they do not subtend a very large angle.

The Matter of Safety

As regards the safety of fliers it must be said that it will depend on the perfect functioning of the engine, and the fact that one of the three United States naval 'planes that started was put out of commission by failure at the beginning of the flight indicates the uncertainty that yet exists for aeroplane motors. The wings are but fragile mechanisms, and their disruption easily accomplished, together with the putting out of commission of the wireless apparatus. The faithful, unerring pigeon can hardly perform his work as rescuer under the conditions of an ocean flight, even though he worked miracles during the war strife.

What man can accomplish, these aviator men will do!

From London to Paris by Subway Very Soon Now

"THIS is one of the great things we should do together," once said the First Napoleon to the then British Ambassador in Paris. The remark was made shortly after the peace of Amiens, and the Emperor referred to a tunnel beneath the English Channel, connecting England and France. A great French engineer named Mathieu had suggested the plan to the daring Napoleon, and he had at once taken it up, as it appealed to his vivid imagination and love of undertakings of a difficult and gigantic nature.

What the British Ambassador's reply was is not a matter of record, but certain it is that the proposal was not at that time looked upon with favor in England, and the tunnel was not undertaken.

It has required more than one hundred years to bring the British people around to Napoleon's suggestion, and it is doubtful if they would even now be receptive if it had not been for the world war and the German U-boats.

In England preliminary work has been begun by starting work to complete the railway line between Dover and Folkestone which was blocked by a huge landslide at the beginning of the war. Millions of tons of earth now are being removed and the line is being laid afresh. When this road is in operation it will bring trains direct from London to the mouth of the proposed tunnel.

A site for the entrance on the French side has been secured, some way from the coast, which, as on the English shore, consists of cliffs, and additional French railway construction also will be necessary.

Present plans provide for the building of two tunnels, each eighteen feet in diameter, connected by cross galleries at intervals of 200 yards. The trains would be worked by electricity, as in the case of the Simplon tunnel, which is twelve and a half miles long, and at present is the longest.

The maximum depth of water on the route is 180 feet, and a cover of chalk 100 feet thick would be left undisturbed above the crown of the tunnel to provide against any danger from an enemy or the sea, so that the tunnel would descend to a level of about 280 feet below the sea's surface.

—Photos from Gilliams ervice.

The exact spot where it is expected the tunnel channel will start. Tons of debris must be removed before the actual tunnelling can be begun

Iron tubes will be built up as the tunnel advances, precisely as in the London "tubes." Owing to the extraordinary advance in the art of tunnelling in recent years, the work could be done quickly, and it is estimated that the tunnel itself could be completed in five or five and a half years.

Sir Francis Fox is mentioned as the engineer who may have charge of the work on the British section of the tunnel. He is a great tunnelling expert, and acted as special adviser for the Swiss government in the boring of the Simplon.

Thirty-two Miles Long

The total length of the tunnel, including the approaches on both sides of the strait, will be thirty-two miles, of which rather more than twenty-one and a half miles will be under the sea. When the tunnel is completed it is estimated that trains can run from London to Paris in less than six hours. As soon as trains can pass under the Channel they will be able to traverse France, Belgium, Holland, Spain, Italy, Germany, Austria-Hungary and Turkey as far as Constantinople without any difficulty as to gauge or minimum structures and without the passengers having to change cars.

In the course of time, doubtless more than two pairs of rails will be required to deal with the enormous volume of traffic which in each direction must inevitably develop.

At labor prices before the war it had been estimated that the cost of the tunnel would be in the neighborhood of $80,000,000, but wages have gone up considerably since then, as well as the cost of raw material, and it now is believed that the tunnel will cost at least $100,000,000 and some day $125,000,000, which probably is close to the correct figure.

In this connection, the financial aspects of this big engineering undertaking are interesting. In 1875 a French company was formed to construct the tunnel from the French end. This company still remains in existence with a concession from the French government, which holds good for ninety-nine years after the opening of the tunnel. So far as France is concerned, this organization doubtless will handle the French end.

Up to British Government

To properly link up the undertaking in the same year the company was formed in France, a British company was also organized and attained Parliamentary powers to undertake experimental work on the tunnel. This company has already expended about a million dollars in preparatory work, and, under the control of the government, it is generally expected that they will now be permitted to carry out the actual work of the tunnel construction, as they are reported to have the necessary financial backing.

On the other hand, as the British company has no such ninety-nine-year concession after the opening of the tunnel as the French company, it is possible that the English government will itself undertake the construction of the tunnel proper. Whichever way the cat jumps, it remains only for the government to press the button for work to begin without delay. According to some enthusiasts not even Parliamentary sanction is required, the government having sufficient powers under the Defence of the Realm act.

While from an engineering point of view the tunnel, when completed, will undoubtedly rank high among the feats accomplished by human skill and labor, at the same time it is not anticipated that any difficulties in the work in this day of advanced engineering will be encountered which cannot be readily overcome.

In the Channel the sea is not the difficulty; the only risk lies in the geological aspect. The first layer under the Channel is white chalk, and beneath this is a belt of gray chalk some 400 feet in depth. The question arises whether or not this gray chalk is impervious to water, for through it engineers consider the tunnel will have to be bored. If it is impervious the tunnelling will be easy compared with the East River tubes.

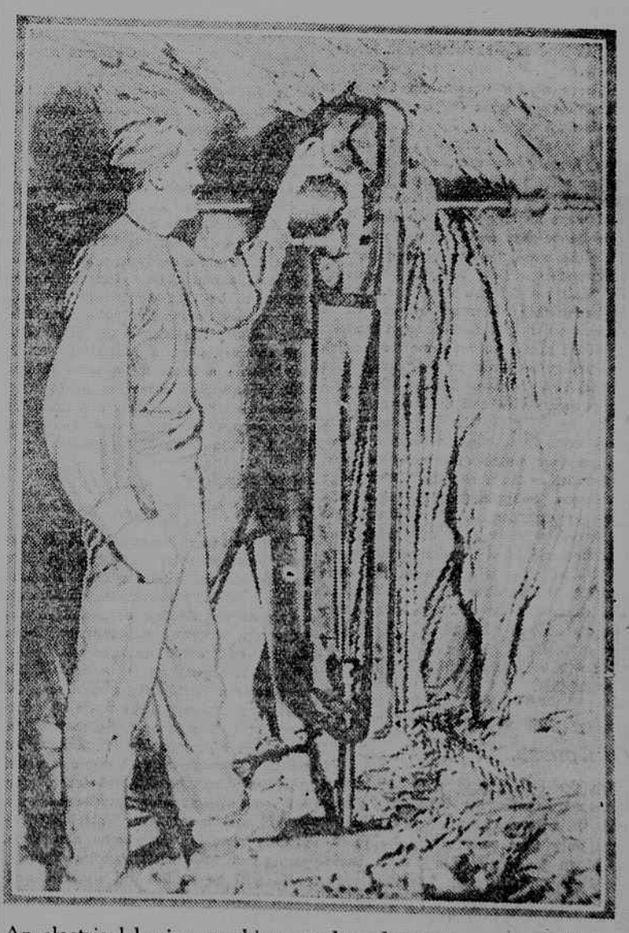
In the building of these it was necessary to bore through hard rock covered with immense glacial boulders overlaid with quicksand. In the case of the Blackwell tunnel the bore was run close under the gravel bed of the river and a blanket of London clay, which is impervious to water, was laid between the gravel and the tunnel.

In connection with the proposed boring of the Channel tunnel, John K. Hencken, an American engineer, has come forward with a plan which he says he has submitted to the British Cabinet and which is now under consideration. Mr. Hencken claims to have invented a wonderful machine which, he claims, will cut through earth and rock almost like cheese at the rate of 100 feet an hour. In fact, so rapidly does his invention work that he asserts that he can have the tunnels completed and ready for operation, at an enormous saving of expense and labor, within a few months' time instead of the years it is now expected will be required to build them.

Mr. Hencken plans to not only have a trackway in each of the four tunnels he proposes, but also a driveway as well, along which motor lorries can be driven from England to bases in France without breaking bulk.

His plan is to have eight of his machines in use, one at each end of the four tunnels, and another set of eight machines boring the approaches at the same time. Two of the tunnels would cut at a depth of 100 feet below the channel bed "to avoid possibility to injury from above," and the other two somewhat lower "to be used as drainage tunnels additionally to their use as traffic tunnels." The bores will be cylindrical in shape, unless it is decided to have both driveways and trackways, in which case the lower half will be cut square or rectangular.

In describing his machine, Mr. Hencken says it consists of a series of swinging hammers rotated at a peripheral speed of about 500 feet a second, striking several hundred thousand blows a minute on the face to be excavated and pulverizing the materials "from five inches in greatest dimension down to impalpable powder." Each blow, he claims, would have the force of a 3-inch solid projectile. The machine, with all appurtenances, is moved forward by a system of caterpillar tractors and the débris is carried away on belt conveyors.



An electrical boring machine, used to determine rock conditions, now at work on the French side of the projected channel tunnel